U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Ocean Service
Center for Coastal Fisheries and Habitat Research
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Comparative analysis of the functioning of disturbed and undisturbed coral reef and seagrass ecosystems in the Tortugas: Phase I- Establishing a baseline

Progress Report # 5

May 1, 2001

and Cruise Report for Legs II and III of

NOAA Ship FERREL Cruise FE-01-07-BL
08 April 2001 - 20 April 2001

Submitted By:

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May 1, 2001

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INTRODUCTION

In July 2001, the full Tortugas Ecological Reserve will take effect. It includes two components: Tortugas North and Tortugas South (Figure 1). Tortugas North is approximately 151 nm^2 and covers the northern half of Tortugas Bank, Sherwood Forest, the pinnacle reefs north of the bank, and extensive low relief areas in the 15-40 m depth range. The latter low relief areas have received little assessment. Tortugas South is approximately 60 nm^2 and encompass Riley's Hump as well as deep water habitats to the south which are reported to provide critical habitat for several snapper species, snowy grouper, tilefish, and golden crab. The implementation of this reserve provides an excellent opportunity for NOAA to investigate the effects of human disturbance (e.g., elimination of consumptive sampling and physical impacts) on the functioning of coral reef and deepwater algal and seagrass ecosystems. Specifically, to determine the efficacy of this management action, several long-term monitoring actions must be taken, including evaluating the local and regional areas in terms of larval fish export, changes in adult fish biomass, and especially, changes in ecosystem structure and associated ecological processes.

The National Centers for Coastal Ocean Science, here headed by the Center for Coastal Fisheries and Habitat Research (CCFHR) and our colleagues both in and out of NCCOS (Center for Coastal Monitoring and Assessment, Coastal Services Center, Florida Marine Research Institute, National Undersea Research Center, and the University of South Florida)are uniquely poised to provide critical mission support to habitat characterization and marine reserve questions that are facing the Tortugas Ecological Reserve (TER) within the Florida Keys National Marine Sanctuary (FKNMS). CCFHR has researched fishery-habitat interactions in south Florida and the Keys since the early 1980's and brings a wide range of scientific expertise to bear on fisheries and habitat issues. Moreover, we are coordinating this work with the research approach and philosophy of applied studies of our other studies in the region - including injury recovery experiments, monitoring and modeling in the FKNMS, linkages among coral reefs and adjacent habitats in Puerto Rico, EFH funding on the contribution of deepwater primary producers to coastal fisheries and gear impact studies, and long-term studies of icthyoplankton distribution, development and transport mechanisms.

The need for detailed habitat characterization is inextricably linked with the reserve issue. Many reef fishes leave the structure of the reef at night to forage in the adjacent sand, algal and seagrass flats, thereby importing significant amounts of nutrients onto the reef environment, contributing to its high productivity. This mass transfer also ultimately contributes to energy requirements of small grazers that cannot themselves access the adjacent, non-coral reef resources. The adjacent seagrass beds are also significant settlement areas for post-larval reef fishes. Over-fishing of the diurnally migrating fishes and/or physical damage to the foraging/settlement environment could significantly alter the reserve's productivity and biological diversity. Therefore, habitat characterization is critical to determine the distribution of sessile resources that are susceptible to injury and which may be poised to rebound once any injury activity is relaxed through implementation of the reserve. Habitat characterization is also crucial to ultimately determine an ecologically optimal size of the reserve complex (i.e., the reef and the adjacent areas upon which reef fauna are dependent) to yield optimum fishery production and maintain the ecological health of the reef ecosystem. Finally, conducting work in the TER provides a unique opportunity to compare the structure and function of a relatively undisturbed system with those elsewhere in the FKNMS and adjacent waters. This comparative approach has significant potential for translating the findings of these studies so as to apply them directly to management issues in other NOAA trust resources.

In support of this research, the NOAA Ship FERREL arrived in Key West, FL on 07 April 2001 to support research objectives of the CCFHR and collaborators (CCMA, CSC, FMRI, NURC, USF) in the Dry Tortugas Ecological Reserve. This marked the final two legs of a three week excursion for the FERREL. A total of eleven scientists representing four federal and state institutions participated in the final leg.

OBJECTIVES

Programmatic: Over the three year period of this work, we have proposed:
1) a preliminary characterization and inventory of the benthic habitat and fish communities in the extreme depths of the Tortugas South reserve component;
2) characterization of spawning aggregations and initiating the development of a probabilistic model of the fate of snapper larvae, focusing on Riley's Hump;
3) beginning comparative characterization of shallow and deepwater seagrass communities and their contribution to fishery resources in disturbed (outside the reserve) and undisturbed sites (inside the reserve);
4) establishment of a baseline for benthic nutrient composition and flux in disturbed and undisturbed sites;
5) determination of the accuracy of existing habitat delineations within the proposed ecological reserve as a function of depth and disturbed and undisturbed sites;
6) examination of how high resolution ecological data of a given habitat type can be scaled to the larger spatial context of the proposed ecological reserve.

Cruise FE-01-07-BL: Here, our objectives were to:
1) Conduct seafloor surveys at selected permanent stations (Figure 2) within Tortugas North, centered around the National Park and the northern boundary of the proposed reserve.
2) Establish permanent transects at each station along the reef/plain interface.
3) Collect comparative data of resident invertebrate, fish and plant populations as part of ongoing Essential Fish Habitat (EFH) research as part of the Florida Keys National Marine Sanctuary (FKNMS) effort to assess the efficacy of the institution of an Ecological Reserve at the Dry Tortugas.

Cruise Component:	08 April 2001	Departed Key West, FL
	13 April 2001	Arrived Key West, FL

-video and sonar mapping along defined transects up to ~3 km length using Quester Tangent SeaView and ROXANN sonar systems in combination with drop cameras during drifts and towed MiniBat; at select stations, deployed divers to establish permanent transects and collect sediment cores and penetration measurements; collected incident radiation and measures of water clarity

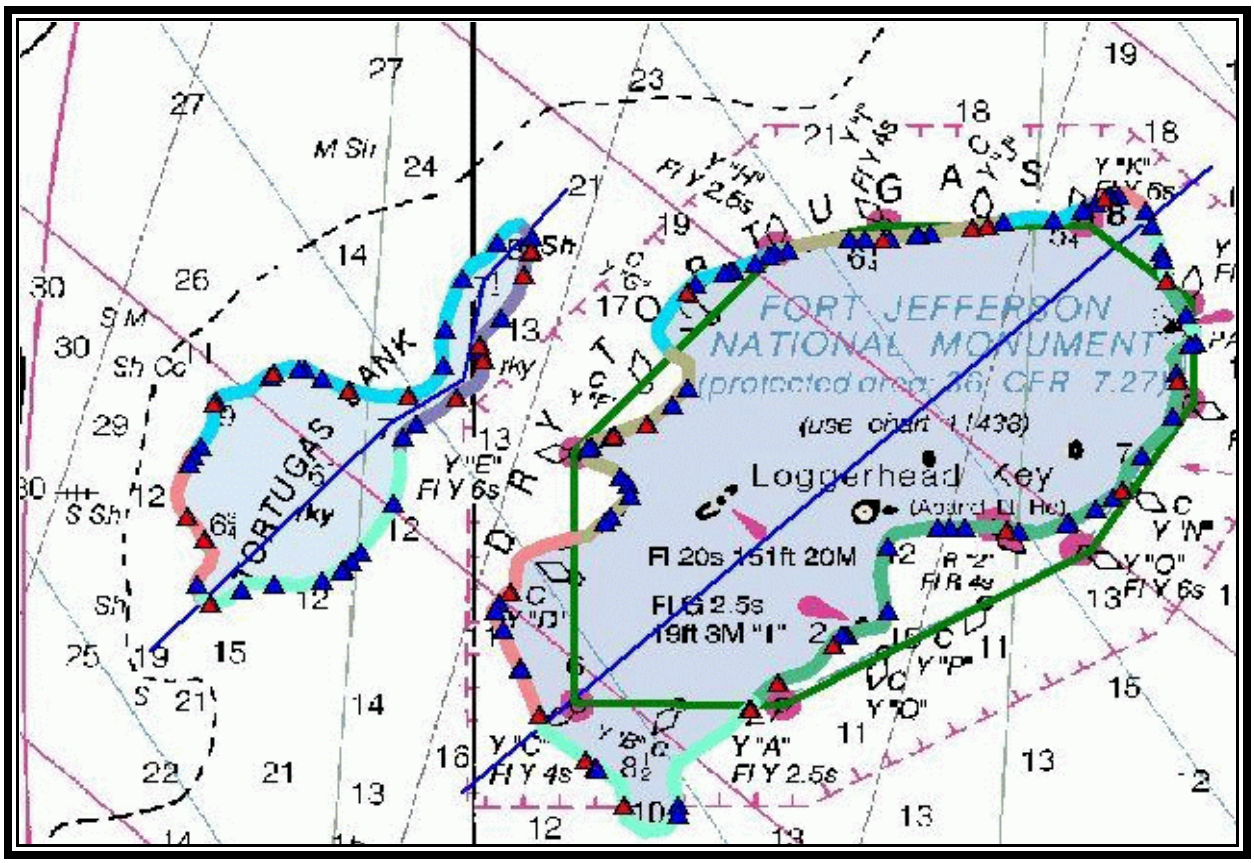

Figure 2. Tortugas North with survey strata and random sites. Blue triangles = all possible random sites. Red triangles = sites where survey transects were conducted and permanent stations established.

Participants:

Name	Title	Affiliation
Mark Fonseca	Chief Scientist	NOS, Beaufort, NC
Amy Uhrin	Field Party Chief	NOS, Beaufort, NC
Donald Field	Geographer	NOS, Beaufort, NC
Craig Bonn	Biological Technician	NOS, Beaufort, NC
Christine Addison	Biological Technician	NOS, Beaufort, NC
Mark Finkbeiner	Geographer	CSC, Charleston, SC
Sean Meehan	Biologist	DAC, FKNMS

Cruise Component: 15 April 2001 Departed Key West, FL
20 April 2001 Arrived Key West, FL

-continued video and sonar mapping along defined transects up to ~3 km length using Quester Tangent SeaView and ROXANN sonar systems in combination with drop cameras during drifts and towed MiniBat; at select stations, deployed divers to establish permanent transects and collect sediment cores during MiniBat tows; collected incident radiation and measures of water clarity

Participants:

Jud Kenworthy	Chief Scientist	NOS, Beaufort, NC
Don Field	Field Party Chief	NOS, Beaufort, NC
Craig Bonn	Biological Technician	NOS, Beaufort, NC
John Brewer	Biological Technician	NOS, Beaufort, NC
Christine Addison	Biological Technician	NOS, Beaufort, NC
Kevin Kirsch	Biologist	DAC, FKNMS
Jitka Hyniova	Biologist	FMRI, St. Petersburg, FL

DRY TORTUGAS ECOLOGICAL RESERVE (NORTH)

Station Location and General Survey Work: Extensive benthic mapping (video transects) within Tortugas North, focusing on the stations surrounding the National Park, was conducted using a MiniBat TOV housing a camera and Quester Tangent SeaView sonar system in combination with a ROXANN sonar system. We will transfer the video-based record of benthic cover at 1 m resolution into a Geographic Information System (GIS: ArcView). The GIS will be used to develop maps of benthic cover to guide the placement of fish censuses, transects, and trawls during the June/July cruise. Beam trawls were taken at selected stations along the aforementioned video transects. Divers were deployed to establish permanent transects and extract sediment cores in conjunction with MiniBat towing. Incident radiation and measures of water clarity were taken when appropriate.

Approach (Specific): Based upon our extensive habitat characterization of this area during the FE-00-09-BL cruise in the summer of 2000, we chose to adopt a sampling protocol that focused on habitat interfaces (i.e. areas where coral reef meets seagrass/algal plains). Our video interpretations and drop camera work from the previous year revealed areas of potential interfaces. Each of these areas was designated as one of six categories: Out North (outside the reserve/park, north of the prevailing current) Out South (outside the reserve/park, south of the prevailing current), Park North (inside the park, north of the prevailing current), Park South (within the park, south of the prevailing current), Reserve North (within the reserve, north of the prevailing current), and Reserve South (within the reserve, south of the prevailing current; Figure 2). Five random sample points were selected from within each of the six categories. In February, during the OT-01-01 cruise, all sample points located at Tortugas Bank were surveyed (Figure 3). In April, all remaining points (surrounding the National Park) were mapped extensively using a MiniBat® TOV housing a vertically-mounted camera and Quester Tangent SeaView® sonar system (Figure 3). An additional sonar system (ROXANN®) was deployed on some of the transects and run simultaneously with the MiniBat unit. Two passes of approximately 1.5 km in length and separated by a distance of ~ 1 km were made at each point (Figure 3). All data collections were georeferenced and time-stamp coordinated. We will transfer the video-based record of benthic cover from each transect by randomly sub-sampling positions at 1 m resolution, inspecting the georeferenced video tape, and recording the seafloor composition into a GIS. The GIS will be used to select additional sites for more intensive sampling (i.e. fish counts, trawls, sediment samples, etc.) during the summer 2001 cruise.

Diving: Divers were deployed to established permanent transects along the reef/plain interface at selected stations. Twelve permanent transects were completed. Additionally, sediment extractions and penetration measurements were made at selected stations. A complete listing of all dive statistics is presented in Appendix I.

Beam Trawl: At randomly selected stations we conducted five minute tows. Samples were initially preserved in formalin (24h) and then transferred to ethyl alcohol.

Ancillary Data: We collected incident radiation and measures of water clarity at select stations along the

aforementioned video transects. We recorded the GIS tracks of all tows, as well as drop camera, beam trawls, incident radiation, and water clarity stations. A complete listing of all data/samples collected is given in Appendices II and III.

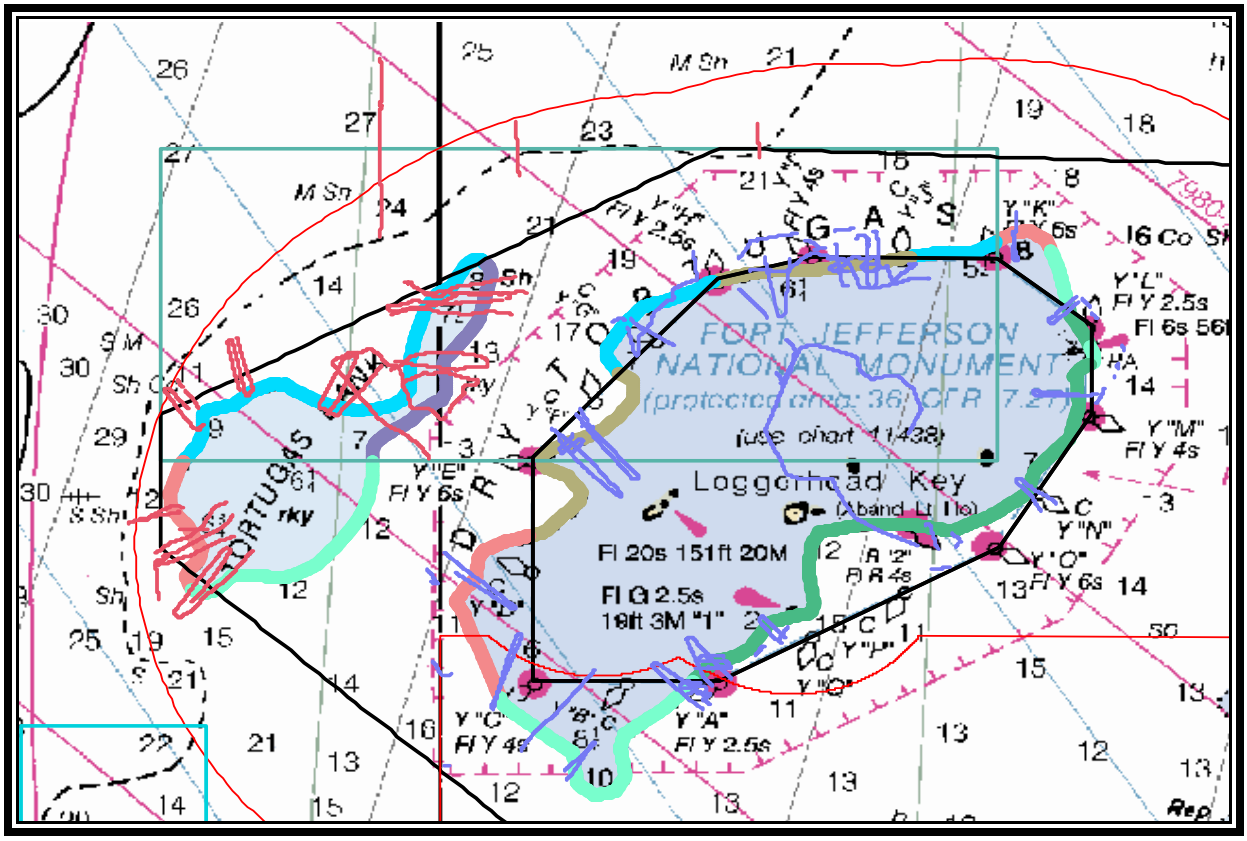

Figure 3. Track lines of video/sonar transects. Pink lines represent February tows aboard the Oregon II. Purple lines represent April tows aboard the FERREL.

APPENDIX I. Dive Statistics

Date	Diver	Depth (ft)	Bottom Time (min)	Medium
08Apr01	Craig Bonn	79	9	NITROX II
8-Apr-01	Amy Uhrin	78	9	NITROX II
9-Apr-01	Craig Bonn	65	31	NITROX II
9-Apr-01	Amy Uhrin	65	31	NITROX II
9-Apr-01	Christine Addison	97	8	21% O_2
9-Apr-01	James Bunn	91	8	21% O_2
4/10/01	Amy Uhrin	70	31	NITROX II
4/10/01	Craig Bonn	70	31	NITROX II

10-Apr-01	Christine Addison	60	28	21% O_2
10-Apr-01	Mark Fonseca	61	28	21% O_2
10-Apr-01	James Bunn	57	8	21% O_2
10-Apr-01	Craig Bonn	57	8	NITROX II
10-Apr-01	Mark Finkbeiner	40	9	21% O_2
11-Apr-01	Amy Uhrin	55	17	21% O_2
11-Apr-01	Mark Fonseca	55	17	21% O_2
11-Apr-01	Jeff Judas	59	21	21% O_2
11-Apr-01	Craig Bonn	59	21	21% O_2
11-Apr-01	Don Field	59	21	21% O_2
11-Apr-01	Sean Meehan	64	21	21% O_2
11-Apr-01	Commander Kuester	64	21	21% O_2
11-Apr-01	Christine Addison	61	30	21% O_2
11-Apr-01	James Bunn	62	30	21% O_2
11-Apr-01	Mark Finkbeiner	62	29	21% O_2
12-Apr-01	Mark Fonseca	95	26	NITROX II
12-Apr-01	Amy Uhrin	96	25	NITROX II
12-Apr-01	Craig Bonn	39	13	21% O_2
12-Apr-01	Don Field	39	13	21% O_2
12-Apr-01	Mark Finkbeiner	40	13	21% O_2
13-Apr-01	Sean Meehan	50	16	21% O_2
13-Apr-01	Christine Addison	50	16	21% O_2
13-Apr-01	Don Field	50	16	21% O_2
13-Apr-01	Mark Finkbeiner	44	15	21% O_2
13-Apr-01	Amy Uhrin	44	15	21% O_2
13-Apr-01	Craig Bonn	44	15	21% O_2
16-Apr-01	Jitka Hyniova	78	32	NITROX II
16-Apr-01	Craig Bonn	77	32	NITROX II
16-Apr-01	Kevin Kirsch	82	30	21% O_2
16-Apr-01	Christine Addison	80	30	21% O_2
16-Apr-01	Judd Kenworthy	72	26	21% O_2

APPENDIX I. Dive Statistics Con't.

Date	Diver	Depth (ft)	Bottom Time (min)	Medium
16-Apr-01	Don Field	72	26	21% O_2
16-Apr-01	Jitka Hyniova	77	34	NITROX II
16-Apr-01	Craig Bonn	77	34	NITROX II
16-Apr-01	Christine Addison	55	32	21% O_2
16-Apr-01	Kevin Kirsch	54	32	21% O_2
16-Apr-01	Craig Bonn	60	35	NITROX II
16-Apr-01	Jud Kenworthy	60	35	NITROX II
16-Apr-01	Scott Kuester	60	35	NITROX II

17-Apr-01	Craig Bonn	95	26	NITROX II
17-Apr-01	Jitka Hyniova	95	26	NITROX II
17-Apr-01	Kevin Kirsch	97	28	NITROX II
17-Apr-01	Jeff Judas	100	29	NITROX II
17-Apr-01	Craig Bonn	98	30	NITROX II
17-Apr-01	Scott Kuester	98	30	NITROX II
17-Apr-01	Jitka Hyniova	100	20	NITROX II
17-Apr-01	James Bunn	100	21	NITROX II

APPENDIX II. Sample Codes

beam trawl	**BEAM**
benthic chlorophyll	**CHL_BEN**
MiniBat tow	**BAT**
drop camera	**DROP**
light meter download	**LGTMETER**
light profile	**LGT (or LGTPRO)**
Secchi disk	**SEC**

QTC View	**QTC**
ROXANN	**ROX**
waypoint	**WPT**
PONAR grab	**PONAR**
sediment penetration	**SED_PEN**
sediment sheer	**SED_SHR**
sediment particle size	**SED_PART**
Super VHS video	**SVHS**
regular VHS video	**VHS**
ASPEN file	**ASP**
fish camera	**FSHCAM**
SCUBA dive	**DIVE**
fish stable isotope	**SI_FISH**
invertebrate stable isotope	**SI_INV**
macroalgae stable isotope	**SI_MAC**

APPENDIX III. Complete Listing of All Data/Samples

DATE	START TIME	STATION ID #	STRATA	SAMPLE CODE	LATITUDE	LONGITUDE
4/8/01		632	PN	ASP	24 43 28.99553	82 50 49.10350
4/8/01		632	PN	FSHCAM	24 43 28.99553	82 50 49.10350
4/8/01	8:28:16 EST	632	PN	BEAM/ASP	24 43.8268893	82 50.9106424
4/8/01	8:58:40 EST	690	PN	BEAM/ASP	24 43.7992257	82 51.5745403
4/9/01				ROX		
4/9/01				QTC		

4/9/01				BAT		
4/9/01	7:23:21 EST			ASP	24 43.0795201	82 49.4893089
4/9/01	12:30:10 UTC			SVHS/VHS		
4/9/01	12:49:33 UTC			QTC		
4/9/01	12:49:33 UTC			SVHS/VHS		
4/9/01	12:57:25 UTC			QTC		
4/9/01	13:02:52 UTC			QTC		
4/9/01	13:10:30 UTC			QTC		
4/9/01	13:18:27 UTC			QTC		
4/9/01	8:40:04 EST			ASP	24 43.53758451	82 53.5598058
4/9/01				BAT		
4/9/01	13:45:04 UTC			QTC		
4/9/01	13:50:14 UTC			QTC		
4/9/01	13:55:45 UTC			QTC		
4/9/01				ROX		
4/9/01	14:33:06 UTC			QTC		
4/9/01				BAT		
4/9/01	9:33:58 EST			ASP	24 44.1607849	82 51.4958840
4/9/01	14:51:54 UTC			QTC		
4/9/01	14:55:14 UTC			QTC		
4/9/01	12:19 EST	632	PN	LGT	24 43 19.99615	82 50 25.05182
4/9/01		632	PN	QTC		
4/9/01		632	PN	QTC		
4/9/01		632	PN	BAT		
4/9/01	11:33:14 EST	632	PN	ASP	24 44.1408810	82 50.6689181
4/9/01		632	PN	ROX		
4/9/01	16:32:34 UTC	632	PN	SVHS/VHS		
4/9/01		632	PN	WPT	24 43 27.55696	82 50 47.27566
4/9/01		690	PN	WPT	24 43 25.51816	82 51 25.64717

4/9/01	17:34:04 UTC	690	PN	QTC		
4/9/01	17:34:04 UTC	690	PN	SVHS/VHS		
4/9/01	18:06:55 UTC	1136	PN	QTC		
4/9/01	18:06:55 UTC	1136	PN	BAT		
4/9/01	13:07:50 EST	1136	PN	ASP	2443.5132197	82 52.4512844
4/9/01	18:06:55 UTC	1136	PN	SVHS/VHS		
4/9/01		1136	PN	ROX		
4/9/01		1136	PN	WPT	24 43 14.05668	82 52 56.75382
4/9/01	15:56:19 EST (CMA)	1915	RN	QTC	24 42.318	82 52.16
4/9/01	15:56:19 EST (CMA)	1915	RN	BAT		
4/9/01	15:05:12 EST	1915	RN	ASP	24 42.0145813	82 55.7250970
4/9/01	15:56:19 EST (CMA)	1915	RN	ROX		
4/9/01	15:56:19 EST (CMA)	1915	RN	SVHS/VHS		
4/9/01	20:22:08 UTC	1915	RN	QTC	24 42.1556	82 55.8660
4/9/01	20:22:08 UTC	1915	RN	BAT		
4/9/01	20:22:08 UTC	1915	RN	ASP	24 42.1728630	82 55.8834625
4/9/01	20:22:08 UTC	1915	RN	ROX		
4/9/01	20:26:44 UTC	1915	RN	SVHS/VHS		
4/9/01	20:23:58 EST	1915	RN	BEAM/ASP	24 42.1079800	82 56.2761419
4/9/01	20:35 EST			LGTMETER		
4/9/01	9:15:43 EST	1136	PN	BEAM/ASP	24 43.9390028	82 52.1560532
4/9/01	21:00:00 EST	1915	RN	SI_FISH		
4/9/01	21:00:00 EST	1915	RN	SI_INV		

4/9/01	18:30 EST	1915	RN	FSHCAM		
4/9/01	21:30:00 EST	1136	PN	SI_INV		
4/9/01	21:30:00 EST	1136	PN	SI_INV		
4/9/01	12:19 EST	632	PN	LGTPRO	24 43 19.99615	82 50 25.05182
4/9/01	2015 EST			LGT_METER		
4/10/01	12:05:50 UTC			SVHS/VHS		
4/10/01	12:07:47 UTC			QTC		
4/10/01	12:05:50 UTC			BAT		
4/10/01	12:05:50 UTC			ASP	24 41.9846979	82 55.9543032
4/10/01				ROX		
4/10/01	12:18:40 UTC			QTC		
4/10/01	12:24:35 UTC			QTC		
4/10/01	12:31:14 UTC			QTC		
4/10/01	12:40:22 UTC			QTC		
4/10/01	12:50:31 UTC			QTC		
4/10/01	13:13:50 UTC			QTC		
4/10/01	13:13:50 UTC			BAT		
4/10/01	13:13:50 UTC			ASP	24 42.8626649	82 53.5821025
4/10/01	13:13:50 UTC			ROX		
4/10/01	13:15:00 UTC			SVHS/VHS		
4/10/01	13:46:42 UTC			QTC		
4/10/01	13:46:42 UTC			BAT		
4/10/01	13:46:42 UTC			ASP	24 41.7220103	82 52.5384062
4/10/01	13:46:42 UTC			ROX		
4/10/01	13:46:42 UTC			SVHS/VHS		

4/10/01	14:08:22 UTC			QTC		
4/10/01	14:19:23 UTC			QTC		
4/10/01	14:49:51 UTC			QTC		
4/10/01	14:49:51 UTC			BAT		
4/10/01	14:49:51 UTC			SVHS/VHS		
4/10/01	15:14:20 UTC	4671	PS	QTC		
4/10/01	15:14:20 UTC	4671	PS	BAT		
4/10/01	15:14:20 UTC	4671	PS	ASP		
4/10/01	15:14:20 UTC	4671	PS	ROX		
4/10/01	15:16:50 UTC	4671	PS	SVHS/VHS		
4/10/01	10:14:23 EST	4671	PS	ASP	24 37.2607224	82 49.5108448
4/10/01	16:00:15 UTC	3926	PS	QTC		
4/10/01	16:00:15 UTC	3926	PS	BAT		
4/10/01	16:00:15 UTC	3926	PS	ASP		
4/10/01	16:00:19 UTC	3926	PS	SVHS/VHS		
4/10/01		3926	PS	WPT	24 38 15.09486	82 47 20.68601
4/10/01		3926	PS	WPT	24 38 24.92402	82 47 30.94594
4/10/01		3926	PS	WPT	24 38 23.83065	82 47 30.73222
4/10/01	12:41:43 EST	3926	PS	LGT		
4/10/01	17:54:32 UTC	2780	PS	QTC	24 40.5088	82 45.8479
4/10/01	17:54:32 UTC	2780	PS	BAT		
4/10/01	17:54:32 UTC	2780	PS	ASP	24 40.5059845	82 45.8384835
4/10/01	17:55:10 UTC	2780	PS	SVHS/VHS		
4/10/01	19:20:26 UTC	1864	PS	QTC		
4/10/01	19:20:26 UTC	1864	PS	BAT		

4/10/01	19:20:26 UTC	1864	PS	ASP	24 42.560654	82 46.2610129
4/10/01	19:20:21 UTC	1864	PS	SVHS/VHS		
4/10/01	20:57:52 UTC	94	ON	QTC		
4/10/01	20:57:52 UTC	94	ON	BAT		
4/10/01	21:02:29 UTC	94	ON	ASP	24 44.1511672	82 47.6755182
4/10/01	20:57:52 UTC	94	ON	SVHS/VHS		
4/10/01	00:26:10 UTC	2780	PS	BEAM/ASP	24 40.6083601	82 45.7031313
4/10/01	01:16:19 UTC	4671	PS	BEAM/ASP	24 36.5911460	82 49.0387718
4/11/01	12:16:20 UTC	park basin		QTC		
4/11/01	12:14:01 UTC	park basin		BAT		
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4/11/01	12:14:01 UTC	park basin		ROX		
4/11/01	12:13:58 UTC	park basin		SVHS/VHS		
4/11/01		park basin		SVHS/VHS		
4/11/01		park basin		QTC		
4/11/01	12:28:47 UTC	park basin		QTC		
4/11/01	12:34:20 UTC	park basin		QTC		
4/11/01	12:39:43 UTC	park basin		QTC		
4/11/01	12:45:08 UTC	park basin		QTC		
4/11/01	12:49:58 UTC	park basin		QTC		
4/11/01	13:11:35 UTC	park basin		QTC		
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4/11/01	13:16:38 UTC	park basin		QTC		
4/11/01	13:28:19 UTC	park basin		QTC		
4/11/01	14:24:50 UTC	6108	PS	QTC		

4/11/01	14:24:50 UTC	6108	PS	BAT		
4/11/01	14:24:50 UTC	6108	PS	ASP	24 34.8927842	82 52.6497448
4/11/01	14:24:50 UTC	6108	PS	ROX		
4/11/01	14:24:54 UTC	6108	PS	SVHS/VHS		
4/11/01	15:05:35 UTC	6493	PS	QTC		
4/11/01	15:05:35 UTC	6493	PS	BAT		
4/11/01	15:05:35 UTC	6493	PS	ASP	24 34.0873617	82 53.7256815
4/11/01	15:05:35 UTC	6493	PS	ROX		
4/11/01	15:05:35 UTC	6493	PS	SVHS/VHS		
4/11/01	15:45:30 UTC	6731	OS	QTC	24 33.7333782	82 54.1684408
4/11/01	15:45:30 UTC	6731	OS	BAT	24 33.7333782	82 54.1684408
4/11/01	15:45:30 UTC	6731	OS	ASP	24 33.7333782	82 54.1684408
4/11/01	15:45:30 UTC	6731	OS	ROX		
4/11/01	15:47:10 UTC	6731	OS	SVHS/VHS		
4/11/01	17:38:07 UTC	7675	OS	QTC	24 31.7838	82 57.2817
4/11/01	17:38:07 UTC	7675	OS	BAT		
4/11/01	17:38:07 UTC	7675	OS	ASP	24 31.2068006	82 57.2396427
4/11/01	17:38:07 UTC	7675	OS	ROX		
4/11/01	17:38:07 UTC	7675	OS	SVHS/VHS		
4/11/01	18:31:19 UTC	7265	OS	QTC	24 32.4495	82.58.2200
4/11/01	18:31:19 UTC	7265	OS	BAT		
4/11/01	18:31:19 UTC	7265	OS	ASP	24 32.4553976	82 58.2206054
4/11/01	18:31:19 UTC	7265	OS	ROX		
4/11/01	18:31:19 UTC	7265	OS	SVHS/VHS		
4/11/01		park basin		DIVE	24 40.7269494	82 52.6357169

4/11/01		park basin		SED_PEN	24 40.7269494	82 52.6357169
4/11/01		park basin		SED_SHR	24 40.7269494	82 52.6357169
4/11/01		park basin		DIVE	24 40.9119140	82 52.5486650
4/11/01		park basin		SED_PEN	24 40.9119140	82 52.5486650
4/11/01		park basin		SED_SHR	24 40.9119140	82 52.5486650
4/11/01		park basin		DIVE	24 41.4338171	82 52.2867430
4/11/01		park basin		SED_PEN	24 41.4338171	82 52.2867430
4/11/01		park basin		SED_SHR	24 41.4338171	82 52.2867430
4/11/01		park basin		DIVE	24 41.5746738	82 52.0221598
4/11/01		park basin		SED_PEN	24 41.5746738	82 52.0221598
4/11/01		park basin		SED_SHR	24 41.5746738	82 52.0221598
4/11/01	6:40 EST			LGT_METER		
4/10/01	12:41:43 EST	3926	PN	LGTPRO		
4/11/01	6:40 EST			LGT_METER		
4/12/01	12:03:20 UTC	6772	ON	QTC		
4/12/01	12:03:20 UTC	6772	ON	BAT		
4/12/01	12:03:20 UTC	6772	ON	ASP	24 33.4221882	82 58.8949672
4/12/01		6772	ON	ROX		
4/12/01	12:03:24 UTC	6772	ON	SVHS/VHS		
4/12/01	13:30:26 UTC	5527	ON	QTC		
4/12/01	13:30:26 UTC	5527	ON	BAT		
4/12/01	13:30:26 UTC	5527	ON	ASP	24 36.4804395	82 59.6787297
4/12/01		5527	ON	ROX		
4/12/01	13:30:28 UTC	5527	ON	SVHS/VHS		
4/12/01	14:46:05 UTC	3275	PN	QTC		
4/12/01	14:46:05 UTC	3275	PN	BAT		
4/12/01	14:46:05 UTC	3275	PN	ASP	24 39.6978395	82 57.5808601
4/12/01		3275	PN	ROX		
4/12/01	14:46:05 UTC	3275	PN	SVHS/VHS		
4/12/01	15:58:30 UTC	3120	PN	QTC		

4/12/01	15:58:30 UTC	3120	PN	BAT		
4/12/01	15:58:30 UTC	3120	PN	ASP	24 39.8680885	82 56.9493307
4/12/01	15:58:30 UTC	3120	PN	ROX		
4/12/01	15:58:30 UTC	3120	PN	SVHS/VHS		
4/12/01	14:32 EST	NW loggerhead key		QTC	24 38.60512980	82 55.8696395
4/12/01	14:32 EST	NW loggerhead key		QTC		
4/12/01	14:50 EST	NW loggerhead key		QTC		
4/12/01	15:23 EST	NW loggerhead key		QTC	24 38.915484	82 56.9586429
4/12/01	15:45 EST	NW loggerhead key		QTC	24 39.2993808	82 56.3469177
4/12/01	15:45 EST	NW loggerhead key		VHS		
4/12/01	16:02 EST	NW loggerhead key		QTC	25 39.4636016	82 56.5051532
4/12/01	16:02 EST	NW loggerhead key		VHS		
4/12/01		3275	OS	DIVE	24 39 20.42657	82 57 09.06267
4/12/01		CALIB 1		DIVE	24 38 36.30779	82 55 52.17837
4/12/01		CALIB 1		SED_PEN	24 38 36.30779	82 55 52.17837
4/12/01	8:16:22 EST	6731	OS	BEAM/ASP	24 33.5808229	82 54.3060052
4/12/01	9:02:33 EST	6108	PS	BEAM/ASP	24 34.9652754	82 52.7007907
4/12/01		6731	OS	SI_INV		
4/12/01		6731	OS	SI_INV		
4/12/01		6731	OS	SI_FISH		
4/12/01		6731	OS	SI_FISH		
4/12/01		6731	OS	SI_FISH		
4/12/01		6731	OS	SI_FISH		
4/12/01		6731	OS	SI_FISH		
4/12/01		6731	OS	SI_FISH		
4/12/01		6731	OS	SI_FISH		

4/12/01		6731	OS	SI_FISH		
4/12/01		6108	OS	SI_FISH		
4/12/01		6108	OS	SI_INV		
4/12/01		6108	OS	SI_FISH		
4/12/01		6108	OS	SI_FISH		
4/12/01		6108	OS	SI_FISH		
4/13/01				QTC		
4/13/01				QTC		
4/13/01				QTC		
4/13/01				QTC		
4/13/01						
4/13/01		CAM1413		DIVE	24 41 30.63795	82 51 42.23244
4/13/01		CAM1413		SED_PEN	24 41 30.63795	82 51 42.23244
4/13/01		CAM1413		SED_SHR	24 41 30.63795	82 51 42.23244
4/13/01		413CAL2		DIVE	24 40 49.41528	82 50 05.26620
4/13/01		413CAL2		SED_PEN	24 40 49.41528	82 50 05.26620
4/13/01		413CAL2		SED_SHR	24 40 49.41528	82 50 05.26620
4/13/01	2010 EST			LGT_METER		
4/12/01	2030EST			LGT_METER		
4/12/01	1310 EST	3120	PN	LGTPRO	24 40.319	82 57.185
4/14/01				LGT_METER		
4/15/01				LGT_METER		
4/16/01	901 EST	6493	PS	DIVE	24 34 27.40321	82 54 05.42992
4/16/01	901 EST	6493	PS	VHS	24 34 27.40321	82 54 05.42992
4/16/01	901 EST	6493	PS	SED_PART	24 34 27.40321	82 54 05.42992
4/16/01	901 EST	6493	PS	CHL_BENa	24 34 27.40321	82 54 05.42992
4/16/01	901 EST	6493	PS	CHL_BENb	24 34 27.40321	82 54 05.42992
4/16/01	901 EST	6493	PS	CHL_BENc	24 34 27.40321	82 54 05.42992
4/16/01	901 EST	6493	PS	CHL_BENd	24 34 27.40321	82 54 05.42992
4/16/01	901 EST	6493	PS	CHL_BENe	24 34 27.40321	82 54 05.42992
4/16/01	901 EST	6493	PS	CHL_BENf	24 34 27.40321	82 54 05.42992
4/16/01	9015 EST	6731	OS	DIVE	24 33 53.50183	82 54 30.18282
4/16/01	9015 EST	6731	OS	VHS	24 33 53.50183	82 54 30.18282
4/16/01	9015 EST	6731	OS	SED_PART	24 33 53.50183	82 54 30.18282

4/16/01	9015 EST	6731	OS	CHL_BENa	24 33 53.50183	82 54 30.18282
4/16/01	9015 EST	6731	OS	CHL_BENb	24 33 53.50183	82 54 30.18282
4/16/01	9015 EST	6731	OS	CHL_BENc	24 33 53.50183	82 54 30.18282
4/16/01	9015 EST	6731	OS	CHL_BENd	24 33 53.50183	82 54 30.18282
4/16/01	9015 EST	6731	OS	CHL_BENe	24 33 53.50183	82 54 30.18282
4/16/01	9015 EST	6731	OS	CHL_BENf	24 33 53.50183	82 54 30.18282
4/16/01	1125 EST	6108	PS	LGTPRO	24 36.773	82 49.411
4/16/01	1030 EST	6108	PS	DIVE	24 35 16.27461	82 53 07.11930
4/16/01	1030 EST	6108	PS	SED_PART	24 35 16.27461	82 53 07.11930
4/16/01	1030 EST	6108	PS	CHL_BENa	24 35 16.27461	82 53 07.11930
4/16/01	1030 EST	6108	PS	CHL_BENb	24 35 16.27461	82 53 07.11930
4/16/01	1030 EST	6108	PS	CHL_BENc	24 35 16.27461	82 53 07.11930
4/16/01	1030 EST	6108	PS	CHL_BENd	24 35 16.27461	82 53 07.11930
4/16/01	1030 EST	6108	PS	CHL_BENe	24 35 16.27461	82 53 07.11930
4/16/01	1030 EST	6108	PS	CHL_BENf	24 35 16.27461	82 53 07.11930
4/16/01	1425 EST	4671	PS	LGTPRO	24 40.24	82 46.05
4/16/01	1339 EST	4671	PS	DIVE	24 37.396	82 49.553
4/16/01	1339 EST	4671	PS	VHS	24 37.396	82 49.553
4/16/01	1339 EST	4671	PS	SED_PART	24 37.396	82 49.553
4/16/01	1339 EST	4671	PS	CHL_BENa	24 37.396	82 49.553
4/16/01	1339 EST	4671	PS	CHL_BENb	24 37.396	82 49.553
4/16/01	1339 EST	4671	PS	CHL_BENc	24 37.396	82 49.553
4/16/01	1339 EST	4671	PS	CHL_BENd	24 37.396	82 49.553

4/16/01	1339 EST	4671	PS	CHL_BENe	24 37.396	82 49.553
4/16/01	1339 EST	4671	PS	CHL_BENf	24 37.396	82 49.553
4/16/01	1450 EST	2780	PS	DIVE	24 40 24.10066	82 46 51.25254
4/16/01	1450 EST	2780	PS	VHS	24 40 24.10066	82 46 51.25254
4/16/01	1450 EST	2780	PS	SED_PART	24 40 24.10066	82 46 51.25254
4/16/01	1450 EST	2780	PS	CHL_BENa	24 40 24.10066	82 46 51.25254
4/16/01	1450 EST	2780	PS	CHL_BENb	24 40 24.10066	82 46 51.25254
4/16/01	1450 EST	2780	PS	CHL_BENc	24 40 24.10066	82 46 51.25254
4/16/01	1450 EST	2780	PS	CHL_BENd	24 40 24.10066	82 46 51.25254
4/16/01	1450 EST	2780	PS	CHL_BENe	24 40 24.10066	82 46 51.25254
4/16/01	1450 EST	2780	PS	CHL_BENf	24 40 24.10066	82 46 51.25254
4/16/01	1900 EST			DIVE	24 42 47.50106	82 46 43.27121
4/16/01	1930 EST			SI_FISH		
4/16/01	1930 EST			SI_COR		
4/16/01	1930 EST			SI_COR		
4/16/01	1930 EST			SI_COR		
4/16/01	1930 EST			SI_COR		
4/16/01	1930 EST			SI_MAC		
4/16/01	2000 EST			SI_COR		
4/16/01	1900 EST			FSHCAM	24 42 45.50164	82 46 40.96722
4/16/01	2045 EST			LGT_METER		
4/17/01	0800 EST	monumenta.ssf		QTC		
4/17/01	0830 EST	monumenta.ssf		QTC		
4/17/01	1022 EST	632	PN	DIVE	24 43 26.32852	82 50 47.67243

4/17/01		632	PN	SED_PART		
4/17/01		632	PN	CHL_BENa		
4/17/01		632	PN	CHL_BENb		
4/17/01		632	PN	CHL_BENc		
4/17/01		632	PN	CHL_BENd		
4/17/01		632	PN	CHL_BENe		
4/17/01		632	PN	CHL_BENf		
4/17/01	1305EST	94	ON	DIVE	24 44 16.14239	82 47 36.77269
4/17/01		94	ON	SED_PART		
4/17/01	12:20 EST			LGTPRO	24 44.388	82 47.103
4/17/01	18:14:42 UTC	632	PN	QTC		
4/17/01	18:14:42 UTC	632	PN	BAT		
4/17/01	18:14:42 UTC	632	PN	ASP	24 43.5286019	82 51.1935727
4/17/01	18:14:42 UTC	632	PN	SVHS/VHS		
4/17/01	18:32:22 UTC	632	PN	SVHS/VHS		
4/17/01	19:42:40 UTC	632	PN	QTC		
4/17/01	19:42:40 UTC	632	PN	BAT		
4/17/01	19:42:40 UTC	632	PN	ASP	24 43.5511846	82 50.9593073
4/17/01	19:42:45 UTC	632	PN	SVHS/VHS		
4/17/01	1533 EST	690	PN	DIVE	24 43 21.24000	82 51 25.68000
4/17/01		690	PN	SED_PART		
4/17/01		690	PN	CHL_BENa		
4/17/01		690	PN	CHL_BENb		
4/17/01		690	PN	CHL_BENc		
4/17/01		690	PN	CHL_BENd		
4/17/01		690	PN	CHL_BENe		
4/17/01		690	PN	CHL_BENf		
4/17/01	1743 EST	1136	PN	DIVE	24 43 16.30060	82 52 28.73839
4/17/01		1136	PN	SED_PART		
4/17/01		1136	PN	CHL_BENa		
4/17/01		1136	PN	CHL_BENb		
4/17/01		1136	PN	CHL_BENc		
4/17/01		1136	PN	CHL_BENd		
4/17/01		1136	PN	CHL_BENe		

4/17/01		1136	PN	CHL_BENf		
4/17/01	21:47:00 UTC	690	PN	QTC		
4/17/01	21:45:23 UTC	690	PN	BAT		
4/17/01	21:46:00 UTC	690	PN	ASP	24 43.5510008	82 51.6765359
4/17/01	21:45:23 UTC	690	PN	SVHS/VHS		
4/17/01	20:15 EST	632	PN	BEAM		
4/17/01	20:40 EST	690	PN	BEAM/ASP	24 43.7807580	82 51.6765359
4/17/01	2100 EST			LGT_METER		
4/18/01		6731	OS	QTC		
4/18/01	12:26:11 UTC	6731	OS	QTC		
4/18/01	12:41:12 UTC	6731	OS	QTC		
4/18/01	12:41:12 UTC	6731	OS	BAT		
4/18/01	12:41:12 UTC	6731	OS	ASP	24 33.7442228	82 54.6545380
4/18/01	12:41:12 UTC	6731	OS	SVHS/VHS		
4/18/01	17:55:12 UTC	6493	PS	QTC		
4/18/01	17:55:12 UTC	6493	PS	BAT		
4/18/01	17:55:12 UTC	6493	PS	ASP	24 34.3346667	82 54.2266533
4/18/01	17:55:12 UTC	6493	PS	SVHS/VHS		
4/18/01	20:05:00 UTC	park basin		QTC	24 38.00025	82 52.8257
4/18/01	1935 EST	6493	PS	ASP	24 34.9266835	82 53.0538229
4/18/01	2055 EST	6493	PS	BEAM/ASP	24 34.8135228	82 53.0099715
4/18/01	1920 EST	4671	PS	ASP	24 37.0898142	82 48.8732351
4/18/01	2020 EST	4671	PS	BEAM/ASP	24 37.1470255	82 48.7942974
4/17/01	800 EST	monumenta.sf		SI_SG		
4/17/01	1533 EST			SI_SG	24 43 21.24000	82 51 25.68000

4/18/01	2020 EST	4671	PS	SI_FISH	24 37.1470255	82 48.7942974
4/18/01	2020 EST	4671	PS	SI_MAC	24 37.1470255	82 48.7942974
4/18/01	2055 EST	6493	PS	SI_FISH	24 34.8135228	82 53.0099715
4/18/01	2055 EST	6493	PS	SI_FISH	24 34.8135228	82 53.0099715
4/18/01	2055 EST	6493	PS	SI_FISH	24 34.8135228	82 53.0099715
4/18/01	2100 EST			LGT_METER		
4/19/01	12:03:50 UTC	6493	PS	QTC		
4/19/01	12:03:50 UTC	6493	PS	BAT		
4/19/01	12:03:50 UTC	6493	PS	ASP	24 34 19.50436	82 54 28.92871
4/19/01	12:03:50 UTC	6493	PS	SVHS/VHS		
4/19/01	1020 EST	7625	OS	PONAR	24 32.175	82 57.104
4/19/01	0950 EST	7675	OS	WPT	24 32 14.74077	82 57 02.40027
4/19/01	19:22:28 UTC	3275	PN	QTC		
4/19/01	19:22:28 UTC	3275	PN	BAT		
4/19/01	19:22:28 UTC	3275	PN	ASP	24 39 36.15497	82 57 09.29729
4/19/01	19:22:28 UTC	3275	PN	SVHS/VHS		
4/19/01		3120	PN	ASP	24 39.7405122	82 56.7019862
4/19/01	01:19:45 UTC	3120	PN	BEAM/ASP	24 39.7812892	82 56.8110218
4/19/01	21:04:30 UTC	5527	ON	ASP	24 36.2322160	83 00.1173833
4/19/01	02:11:29 UTC	5527	ON	BEAM/ASP	24 36.2092016	83 00.0384998
4/19/01	21:30:10 UTC	6772	ON	ASP	24 34.1678740	82 59.8060391
4/19/01	02:55:01 UTC	6772	ON	BEAM/ASP	24 34.1562310	82 59.9560188
4/19/01	22:21:54 UTC	7265	OS	ASP	24 32.1064432	82 59.7763378
4/19/01	2020 EST	monumenta.sf		BEAM/ASP	24 40.7027612	82 52.5858617
4/19/01	1400 EST			LGT_METER		

4/19/01	2020 EST	monumenta.sf		SI_FISH	24 40.7027612	82 52.5858617
4/19/01	2020 EST	monumenta.sf		SI_INV	24 40.7027612	82 52.5858617
4/19/01	01:19:45 UTC	3120	PN	SI_FISH	24 39.7812892	82 56.8110218
4/19/01	01:19:45 UTC	3120	PN	SI_INV	24 39.7812892	82 56.8110218